ABSTRACT

In a double-blind study, room-temperature lidocaine was injected randomly into 1 eyelid of 40 patients during facial anesthesia. The other eyelid of the same eye received injection of warm lidocaine (group 1) or bicarbonate-buffered lidocaine (group 2). Based on a pain scale, warming or buffering lidocaine did not significantly reduce the amount of infiltration pain. Buffering lidocaine was effective in reducing the quality of pain, as judged by the patient's report of dominant pain.

ORIGINAL ARTICLE

Effect of Warming and Buffering Lidocaine on Pain During Facial Anesthesia

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Small-incision cataract surgery procedures have provided simpler techniques such as topical intracameral, subconjunctival, and sub-Tenon anesthesia, but ophthalmologists still use bulbar and facial anesthesia in most of their procedures. Although local anesthetic agents are used for analgesia, they can cause considerable discomfort, especially on skin infiltration.[1-3] The needle size, the volume of the anesthetic agent, and the rate of injection have been shown to cause pain.[4] On the other hand, the chemical properties of the local anesthetics and their interaction with nerves have been shown to play an important role in pain development. Several studies have explored the relationship between various factors and pain of injection. The effect of pain reduction of warming[5,6] and pH adjustment of local anesthetics[7,8] has been investigated by some researchers, but their results are conflicting.[9-11]

This study was made to assess whether warming or buffering lidocaine would reduce infiltration pain in patients receiving facial anesthesia for their cataract surgeries.

Materials & Methods

Forty patients, who were to undergo cataract extractions with the use of retrobulbar anesthesia combined with facial anesthesia, were enrolled into this prospective, randomized, double-blind study, according to the study design approved by our institution's ethics committee. Informed consent was obtained. Patients were randomized into 2 groups of 20 each, according to the anesthetic solutions used for facial anesthesia. In

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group 1 patients, room-temperature lidocaine was injected into either the inferior or superior eyelid, selected randomly, of the eye undergoing surgery, and lidocaine warmed to body temperature was injected into the other eyelid of the same eye. Patients in group 2 also randomly received injection of room-temperature lidocaine in 1 eyelid, but the other eyelid received injection of buffered lidocaine as the anesthetic solution during facial anesthesia.

Demographic data are listed in Tables 1 and 2 for group 1 and group 2, respectively. Group 1 was composed of 12 men and 8 women, with a mean age of 66.5 years (SD, 8.5). Group 2 had 10 men and 10 women, with a mean age of 69.8 years (SD, 10.22).

Lidocaine (2-mL Jetocaine ampoules consisting of 20 mg/mL lidocaine hydrochloride and 0.0125 mg/mL adrenaline) was used as the local anesthetic agent. In this study, lidocaine solutions referred to as room-temperature lidocaine were stock lidocaine ampoules, which a pilot study showed were at 19°C to 20°C when kept at room temperature. The same pilot study showed that warming stock lidocaine ampoules in a baby bottle warmer (Avent) up to 48°C was found to provide lidocaine at 36.5°C to 38.0°C for 2 minutes when 2.5 mL was drawn up into a 5-mL disposable syringe. This method of warming was used to warm lidocaine to body temperature in this study.

In another pilot study, stock lidocaine ampoules were measured to have a pH of 5.98. The addition of 1 unit of sodium bicarbonate ($NaHCO_3$) into 10 units of stock lidocaine was found to neutralize lidocaine, with a resultant pH of 7.16. This group of lidocaine solutions was referred to as buffered lidocaine. Two separate 5-mL injectors were prepared for the facial anesthesia. One of the injectors was filled with 2.5 mL of stock (room-temperature) lidocaine, and the other with 2.5 mL of warm (body-temperature) lidocaine or 2.5 mL of neutralized (buffered) lidocaine according to the study group. The injectors were prepared and marked secretly by 1 investigator (H.T.). Another investigator (O.E.) injected the lidocaine for facial anesthesia in all patients using a standardized, modified Van Lint technique. Upper and lower eyelid injections were made separately using 2 different syringes that had already been prepared. The first injection was made at one third distal of the eyebrow; 1.5 mL of the anesthetic solution from the randomly chosen syringe was injected medially. The remaining 1.0 mL was injected laterally. The estimated injection time was 5 seconds: 3 seconds for the medial injection and 2 seconds for the lateral. A parallel injection was made with the other anesthetic solution in the same quantity as for the lower eyelid, using the same technique and injecting the solution at the same speed.

The patient was asked to quantify the sensation of infiltration pain (disregarding the pain of needle penetration), by using a visual linear analogue scale. This linear scale was a 10-unit ruler, from 0 to 10, with 0 indicating no pain and 10 indicating the greatest imaginable pain. When the surgeon completed the block of each eyelid, the amount of pain sensation was asked and recorded as the pain score of the particular anesthetic solution used. When the injections to both eyelids were completed, and the pain scores were recorded, the patient was asked, ignoring the pain scores given, whether any of the injections had caused a stronger, long-lasting, or more apparent pain. The reply was recorded as the preference of dominant pain sensation. Even in cases when the pain scores of both solutions were the same, the patient was asked whether the pain was sharper on 1 of the injections.

In this study, the sensation of pain was evaluated in 2 forms: The quantity of pain felt during skin infiltration was recorded as the pain score, and the relative comparison of discomfort felt during the anesthesia was recorded as the dominant pain. The pain score thus was quantitative and dominant pain was a qualitative measurement of the sensation of pain during facial anesthesia. Linear analogue pain scores were evaluated with Wilcoxon matched pairs signed rank test. The dominant pain preferences were evaluated with the χ^2 test. A significance level of $P < .05$ was assigned.

Results

Table 1 shows the pain scores and the dominant pain preferences of group 1, in which injection of room-temperature vs body-temperature lidocaine was compared. In group 1, pain scores of room-temperature lidocaine injection varied between 2 and 7, with a mean of 4.50 (SD, 1.46), and pain scores of body-temperature lidocaine injection ranged between 2 and 7, with a mean of 3.90 (SD, 1.61). No statistically significant difference was found between the pain scores of room-temperature and body-temperature lidocaine injections.

In group 1, 10 patients (50%) had dominant pain during the injection of room-temperature lidocaine, 4 patients (20%) had dominant pain during the injection of body-temperature lidocaine, and 6 patients (30%) had no preference of dominant pain. There was no statistically significant difference in dominant pain sensation of the injection of either anesthetic solution.

Table 2 shows the pain scores and the dominant pain preferences of group 2, in which injection of stock (room-temperature) and buffered (neutralized) lidocaine was compared. In group 2, pain scores of stock lidocaine injection varied between 2 and 8, with a mean of 4.75 (SD, 1.78). Pain scores of buffered lidocaine injection varied between 2 and 6, with a mean of 3.20 (SD, 1.19). No statistically significant difference was found between the pain scores of room-temperature and body-temperature lidocaine injections.

In group 2, although 13 patients (65%) had dominant pain during the injection of stock lidocaine and 7 patients (35%) had no preference of dominant pain, injection of buffered lidocaine did not cause dominant pain in any of the patients.

When the pain scores of both groups were compared, no statistically significant difference was found. When the preferences of dominant pain sensation of both groups were compared, buffered lidocaine

TABLE 1

Group 1 Demographic Data, Pain Scores, and Dominant Pain Preferences

Patient No.	Age (y)/Sex	Pain Score: Room-Temperature Lidocaine	Pain Score: Body-Temperature Lidocaine	Dominant Pain
1	88/M	4 (I)	4 (S)	I
2	69/F	6 (S)	6 (I)	—
3	57/F	4 (S)	4 (I)	S
4	65/M	6 (I)	4 (S)	I
5	61/M	4 (I)	2 (S)	I
6	57/M	4 (I)	2 (S)	—
7	76/M	4 (S)	6 (I)	I
8	56/M	2 (S)	2 (I)	—
9	55/M	4 (S)	6 (I)	—
10	80/F	5 (S)	7 (I)	I
11	57/F	6 (S)	2 (I)	S
12	67/F	4 (I)	4 (S)	S
13	52/M	6 (S)	4 (I)	S
14	62/M	4 (I)	2 (S)	I
15	60/M	2 (S)	2 (I)	—
16	70/F	6 (I)	4 (S)	I
17	59/F	4(S)	3 (I)	S
18	57/M	6 (I)	6 (S)	—
19	69/M	7 (S)	4 (I)	S
20	62/F	2 (I)	4 (S)	S

I indicates inferior eyelid; S, superior eyelid; and —, no preference.

injection was found to cause significantly less dominant pain sensation compared with stock and warm lidocaine injections ($P < .05$).

None of the patients had any complication or side effect of the local anesthetic solutions used in this study.

Discussion

Local anesthesia is the most commonly used type of anesthesia in ophthalmology.[11,12] Modern surgical procedures have enabled faster surgeries with shorter recovery time, leaving the application of local anes-

TABLE 2

Group 2 Demographic Data, Pain Scores, and Dominant Pain Preferences

Patient No.	Age (y)/Sex	Pain Score: Room-Temperature Lidocaine	Pain Score: Body-Temperature Lidocaine	Dominant Pain
1	70/F	4 (I)	4 (S)	—
2	80/F	6 (S)	4 (I)	S
3	57/F	4 (I)	4 (S)	—
4	66/M	4 (I)	4 (S)	—
5	75/M	6 (I)	2 (S)	I
6	70/F	6 (I)	2 (S)	I
7	72/M	6 (S)	4 (I)	S
8	70/F	6 (I)	2 (S)	I
9	65/M	2 (S)	2 (I)	S
10	63/M	4 (S)	4 (I)	S
11	59/M	4 (S)	4(I)	—
12	67/F	4 (I)	2 (S)	I
13	74/M	6 (S)	2 (I)	S
14	72/M	2 (S)	2 (I)	—
15	80/M	4 (I)	2 (S)	I
16	78/F	5 (S)	6 (I)	S
17	71/F	4 (S)	4 (I)	—
18	54/M	4 (S)	4 (I)	—
19	66/F	6 (I)	2(S)	I
20	69/F	8 (S)	4 (I)	S

I indicates inferior eyelid; S, superior eyelid; and —, no preference.

thetics to be the most unpleasant and painful phase of the surgery for the patient. Although anterior segment surgeons have started to convert to using topical anesthesia, most ophthalmologic surgeries still are being done using local anesthesia. Hence, much effort is placed on avoiding the complications and discomfort of local anesthesia.

Adrenaline is often used in retrobulbar anesthesia to counteract the vasodilating effects of the local anesthetics. It has been shown to slow the absorption of the anesthet-

ic by local vasoconstriction and thus to prolong the duration of anesthesia, to decrease the amount of anesthetic needed, and to lessen the danger of systemic toxicity.[13]

Factors such as needle size, volume of anesthetic solution, and the speed of injection may affect the pain of injection.[4] Boggia[14] was the first to suggest that warming local anesthetic solutions may reduce the pain of their infiltration. His study attracted the research interest of anesthetists, plastic surgeons, and dentists, but conflicting results have been presented. Some authors presented the favorable effect of warming local anesthetics on pain reduction.[5,6,15-18] Nerve endings have been suggested to be sensitive to cold; greater nociceptor stimulation may be possible with solutions colder than the body temperature. Davidson and Bloom[6] suggested that warming lidocaine would reduce the latent period as a consequence of temperature-related changes in the pK_a of lidocaine, resulting in a faster onset of neuronal blockade and inhibiting impulse conduction before the noxious stimulus is fully appreciated. Mehta et al,[19] on the other hand, suggested that warming bupivacaine would provide a faster epidural anesthesia.

We could not observe a statistically significant effect of warming lidocaine on reduction of pain during facial anesthesia. Moreover, the preference of dominant pain on the area where warm lidocaine was injected in 4 (20%) of 20 patients has increased our doubt of the favorable effect of warming anesthetic solutions.

Local anesthetics have been shown to be more soluble and stable at an acidic pH. However raising the pH by the addition of sodium bicarbonate has been suggested to result in enhanced efficacy when the anesthetic is used for regional blockade.[20-22] Two mechanisms have been proposed to explain the decrease in pain on infiltration with buffered anesthetic solutions. The first proposed mechanism is that the infiltration of an anesthetic solution at physiologic pH levels of 7.0 to 7.4 would cause less tissue irritation compared with a more acidic solution. The second hypothesis is that neutralizing anesthetic solutions would increase their uncharged basic form; thus, the diffusion of the anesthetic solution through interstitial tissues is increased. This would result in a higher concentration of the drug in the nerve axoplasm and a more rapid block of the sensory fibers. As a more rapid block develops, the pain on skin infiltration is believed to be blocked before it has even been sensed.[5,8,23]

Some authors have presented their results showing that buffering lidocaine might improve its effect and reduce the pain on skin infiltration, but, as far as we know, no contrary result has been presented. Our results, in fact, did not show a statistically significant effect of buffering lidocaine on quantitative pain scores compared with stock and warm lidocaine. On the other hand, buffered lidocaine was found to cause significantly less dominant pain in our study. None of the patients reported that they felt dominant pain with buffered lidocaine injection.

In summary, warming or buffering lidocaine was found to have no significant effect on reducing the amount of pain of infiltration during facial anesthesia. However, buffering lidocaine was found to be effective in reducing the quality of pain.

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